



NIST Smart Manufacturing Systems Test Bed

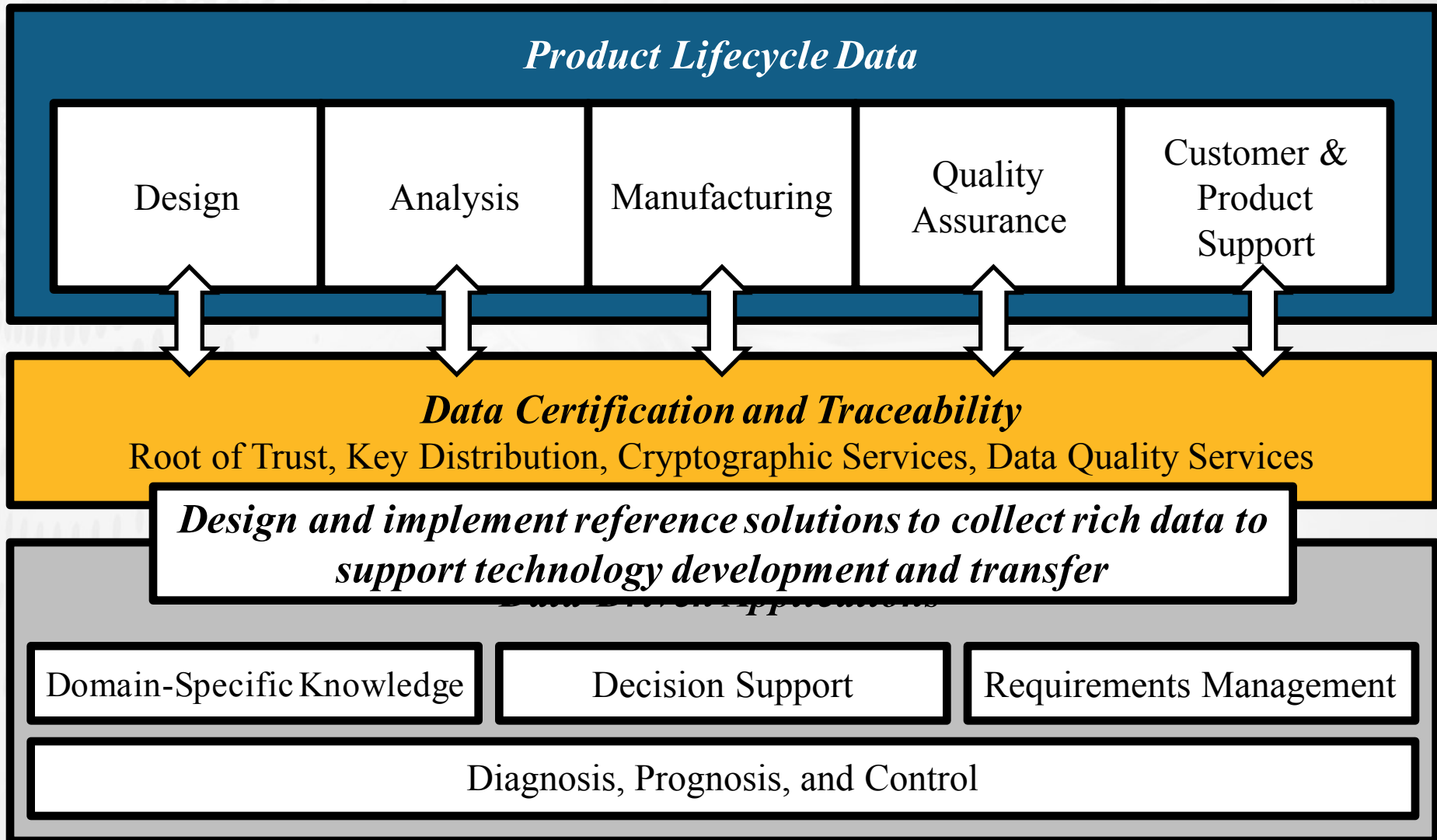
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and Bill Bernstein
Systems Integration Division

Disclaimer

- Identification of commercial systems does not imply recommendation or endorsement by NIST
- Identified commercial systems are not necessarily the best available for the purpose



Lifecycle Information Framework



Current Challenges

- PLM solutions:
 - CAX: CAD, CAE, CAM, etc.
 - PDM
 - V&V

Primarily IT;
Engineering focused;
Relatively expensive
- Operations solutions:
 - Devices, SCADA, PLC
 - MES, MOM
 - ERP

Mixture of IT and OT;
Lack of integration
across control levels

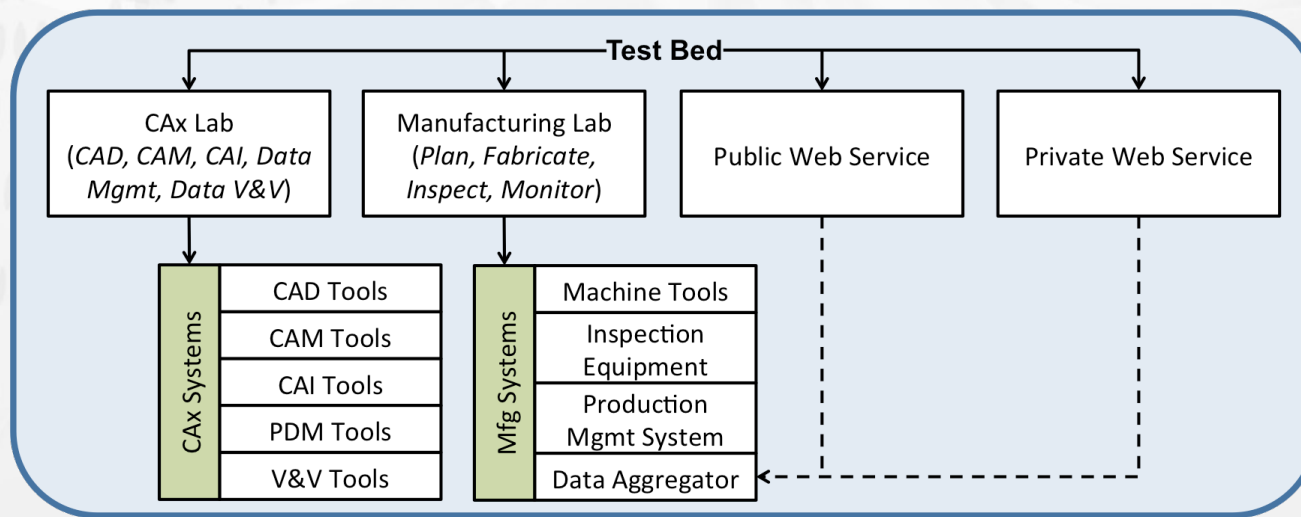
Integration of heterogeneous solutions across the product lifecycle for SMEs and larger organizations



NIST Smart Mfg. Systems Test Bed

Goals:

- Reference architecture and implementation
- Rich source of data for research community
- Physical infrastructure for standards and technology development
- Demonstration test cases
- Improvements in Fabrication Technology operations

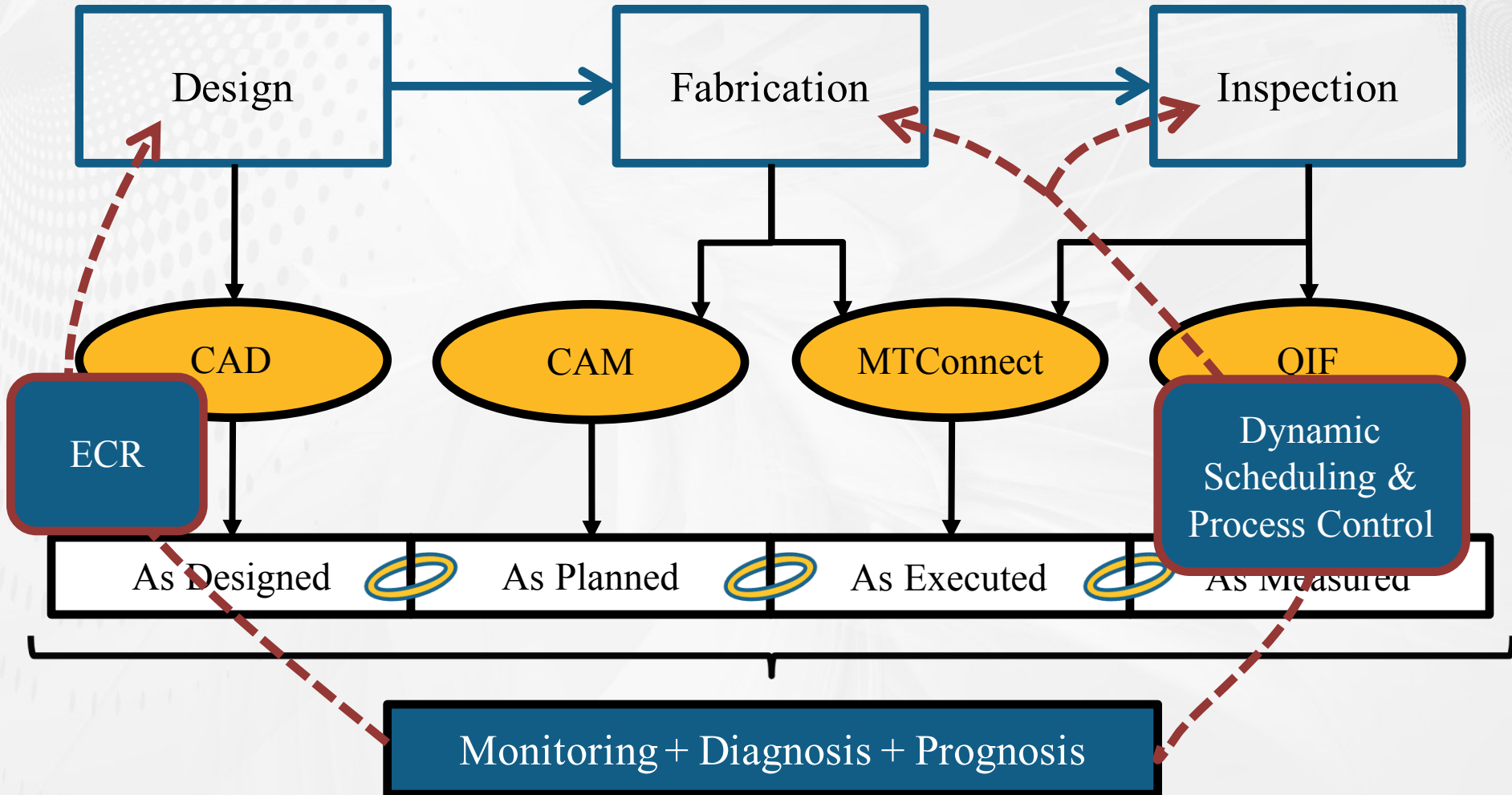


Prototype
complete

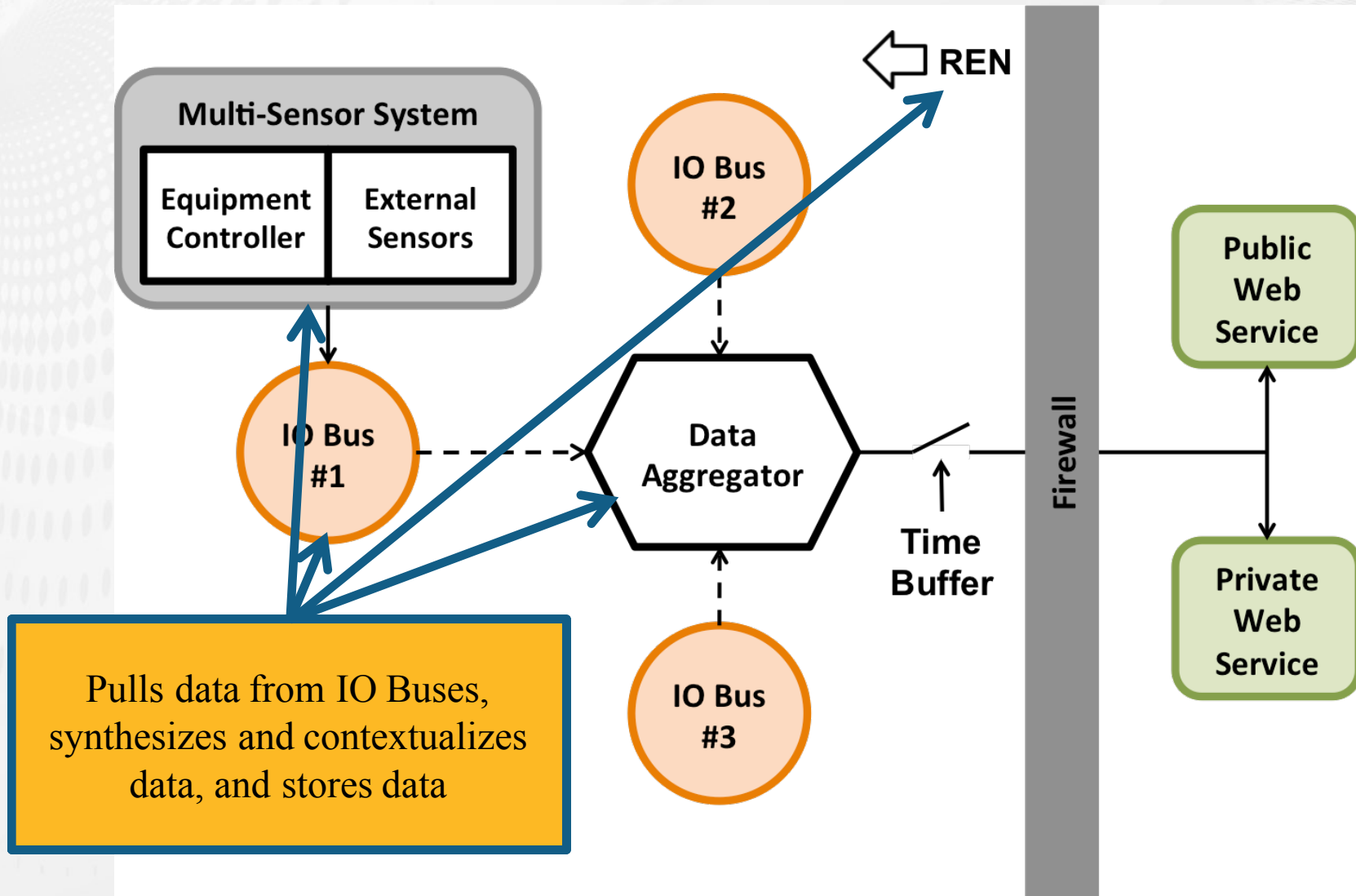
Full
deployment
May 1st



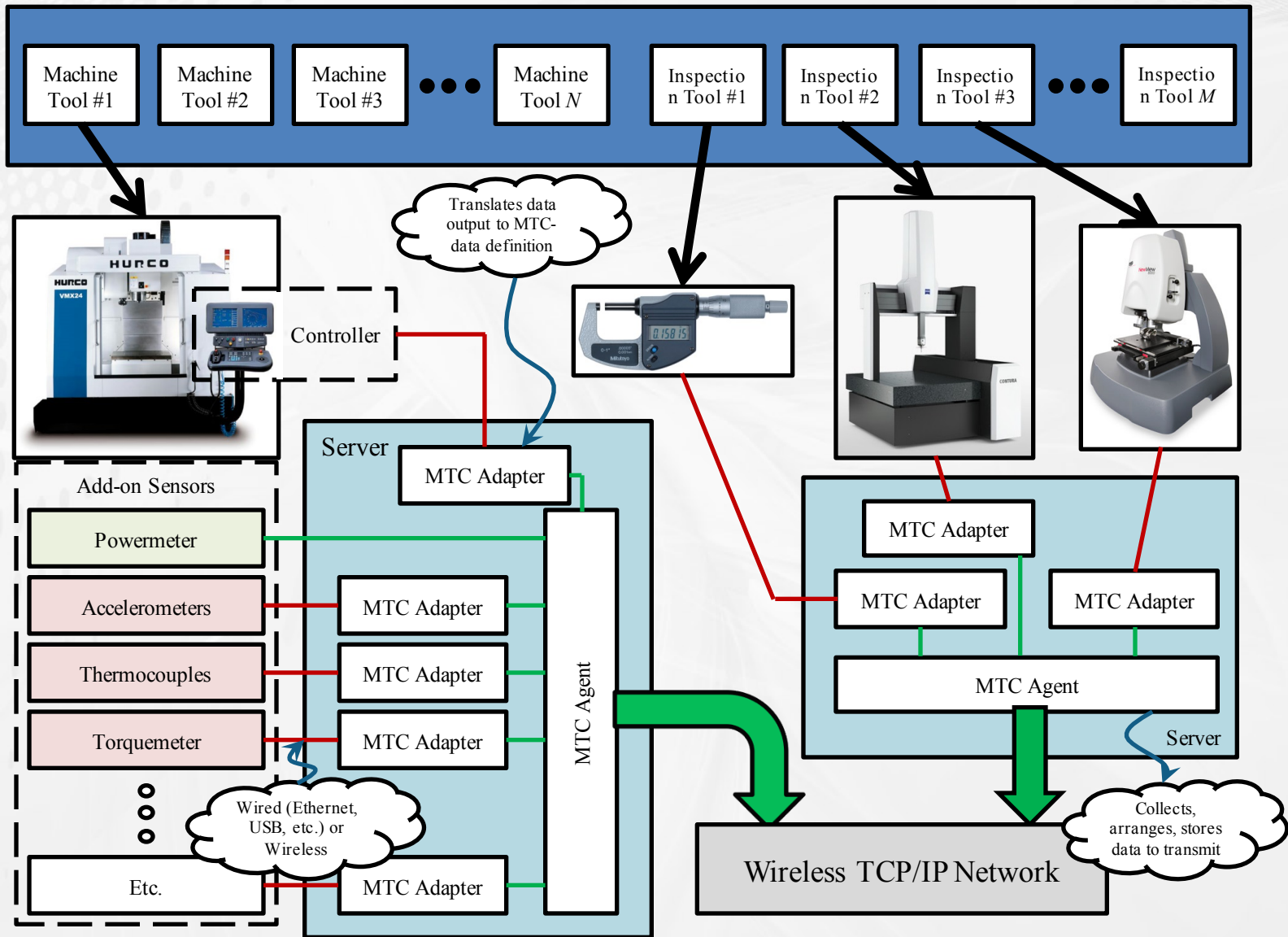
Data Collection and Aggregation



Shop-Floor Implementation



MTCConnect: Key Mfg. Standard



Public and Private Web Services

- Public web service
 - Volatile data streams of manufacturing data from processes and equipment
 - Query-able database repository
 - Data packages for testing, verification, and validation
- Private web service
 - Similar to public web service except includes data and information shared internally that is not ready for public release



Volatile Data Stream

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Smart Manufacturing Systems Test Bed

Volatile Data Stream

You are viewing the Volatile Data Stream (VDS) component of the NIST Smart Manufacturing Systems (SMS) Test Bed located in Gaithersburg MD USA. Please visit the [SMS Test Bed Information Page](#) for more information.

- creationTime: 2016-04-05T14:48:52Z
- sender: mulder
- instanceId: 1459827175
- version: 1.3.0.16
- bufferSize: 131072
- nextSequence: 214354
- firstSequence: 83282
- lastSequence: 214353

Device: NIST-SMS-TestBed-5Axis; UUID: nist_testbed_GF_Agie_1_3a0e8a

Rotary : A

Samples

Timestamp	Type	Sub Type	Name	Id	Sequence	Value
2016-04-05T14:11:29.684741	Angle	ACTUAL	ApositionA	92207523		-0.0001

Rotary : C

Samples

Timestamp	Type	Sub Type	Name	Id	Sequence	Value
2016-04-05T12:48:28.634491	Angle	ACTUAL	CpositionC	90181108		0.0278

Device : NIST-SMS-TestBed-5Axis

Events

Timestamp	Type	Sub Type	Name	Id	Sequence	Value
2016-04-05T14:10:55.190783	AssetChanged			GF_Agie_1_78_asset_chg	207479	.06_FEM-3FLT
2016-04-05T03:32:55.976037Z	AssetRemoved			GF_Agie_1_78_asset_rem	69	UNAVAILABLE
2016-04-05T11:11:21.617246	Availability		avail	dtop_79	123411	AVAILABLE
2016-04-05T11:11:21.617353	EmergencyStop		estop	dtop_80	123412	ARMED

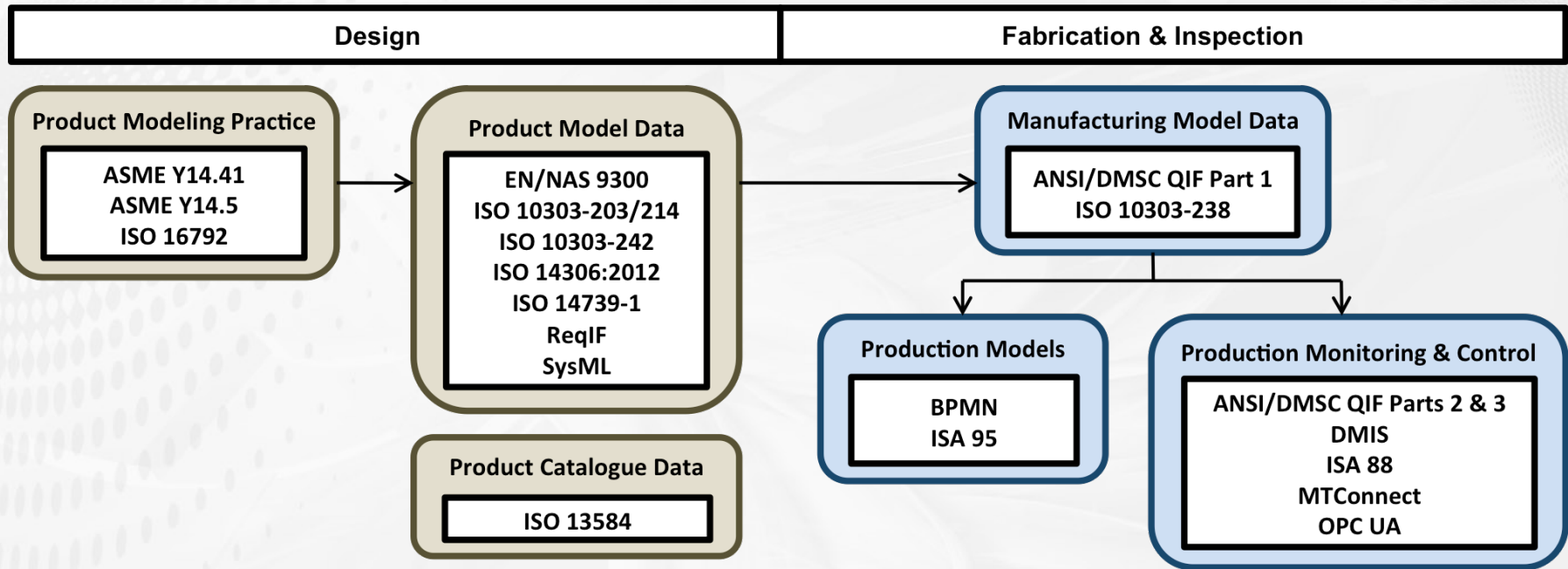
Target Launch Date:
May 1st

Virtual Factory Data

- Test bed can serve as virtual factory since data is presented for each process or equipment on shop floor
- Data does not need to be validated against a real system
- Data is presented in “raw” form including any deficiencies expected from industrial environments
- Data enables fabrication-focused research, including:
 - Data preprocessing, validation, robustness, and quality
 - Condition monitoring, diagnosis, and prognosis
 - Process monitoring and data analytics



Standards and Technology Development



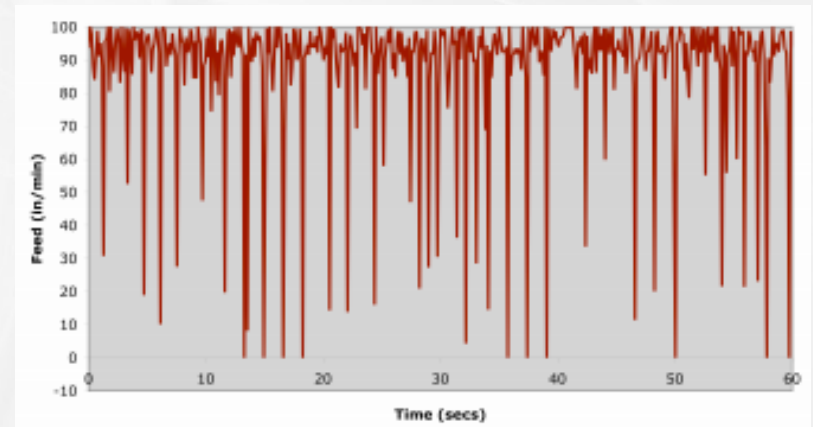
- Test and validate enhancements to standards
- Integrate domain standards to connect information across design and manufacturing
- Develop optimized data packages for technology verification and validation



Demonstration: Feed Analysis

- Feed influences:
 - Quality of finished machined surface
 - Time required to complete operation
- Acceleration of feed drives causes discrepancy between actual and commanded feed

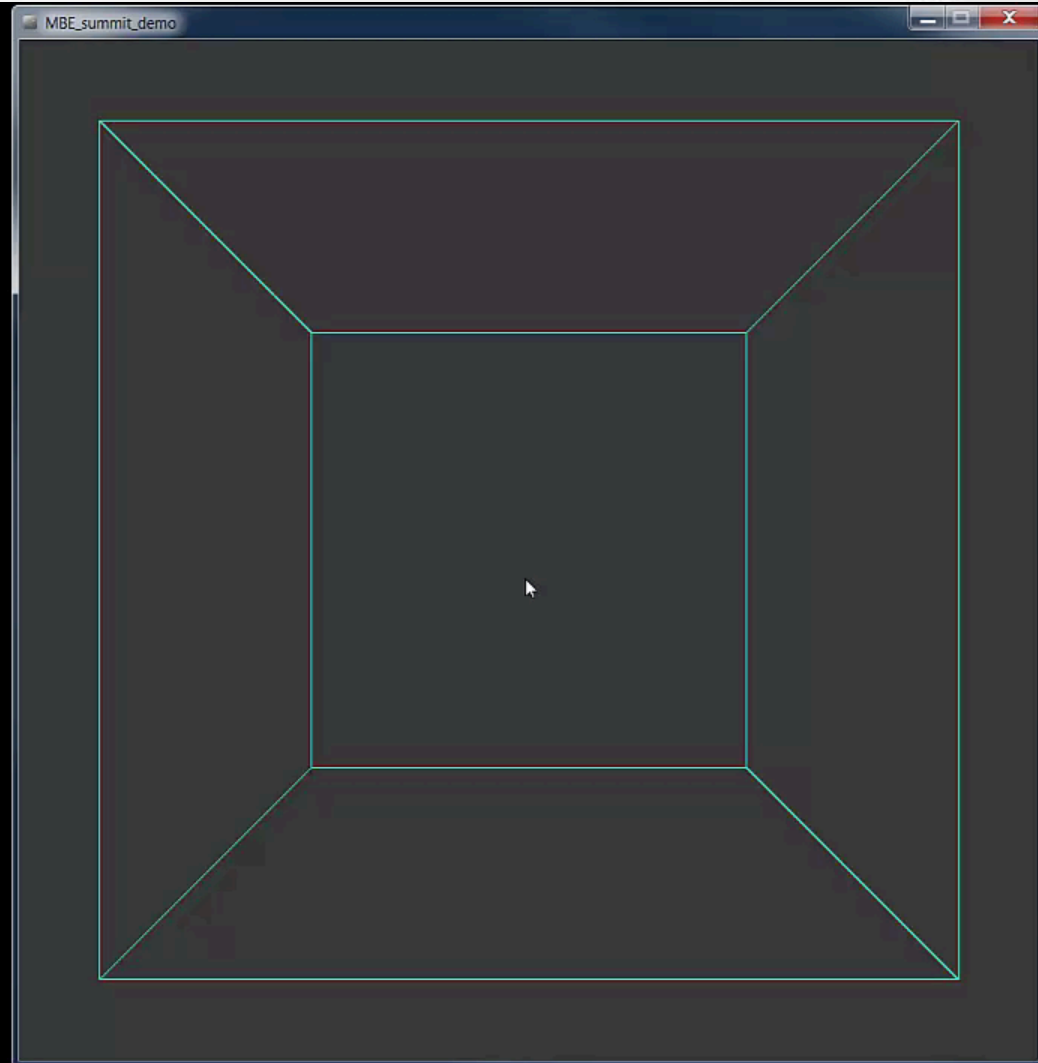
Important to identify
where and when
discrepancy occurs



Vijayaraghavan et al. (2008)



Demonstration: Feed Analysis



Applying Info to Improve Processes

- [***Design***] Can we redesign geometry to avoid the need for toolpaths with high feed discrepancies?
- [***Planning***] Can we redesign toolpath to minimize impact of machine dynamics?
- [***Machining***] Can we enable operator to make informed decisions?
- [***Inspection***] Can we use information to identify areas for more detailed measurement?



Summary

- **May 1st target for full deployment**
- Reference implementation documents – guides, recommendations, specifications, methods – to be released
- Please stay tuned for more info!

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